DAQ installation + noise measurements

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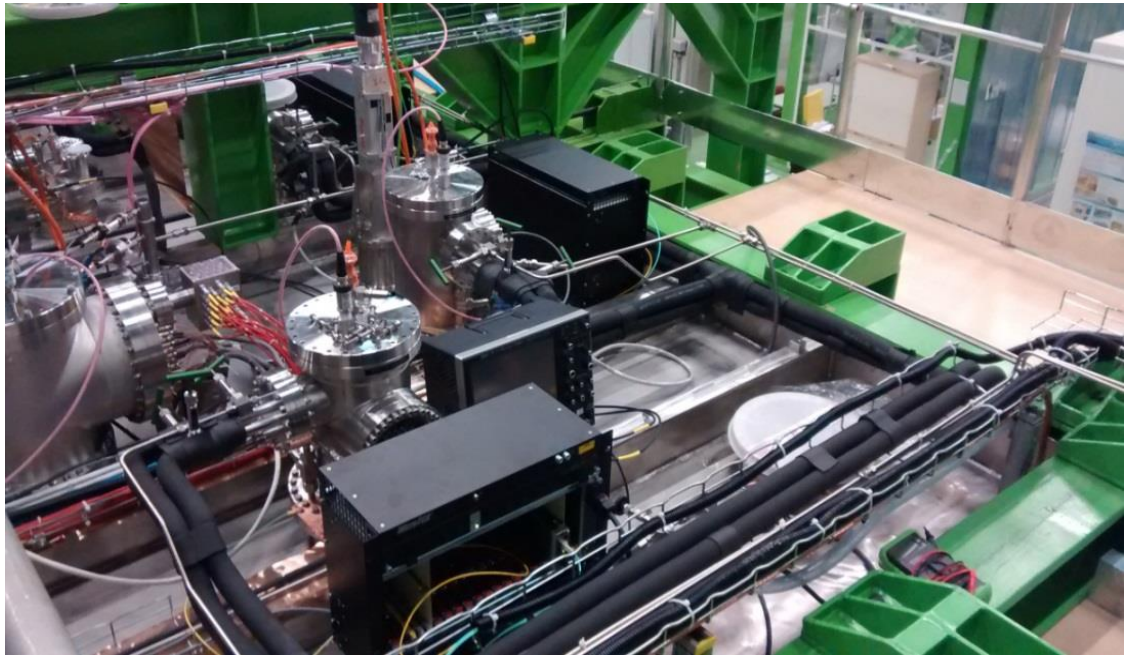
We had several campaigns of measurements of the noise and grounding since June 2016: regularly reported at the 3x1x1 meetings

- The FE was fully installed in the campaign of 13-16/9/2016

(see presentation at the 3x1x1 meeting of 22/9/2016 and 14/10/2016

On 18-20/10 we performed the installation of the uTCA racks and optical fibers cabling of data network and white rabbit network and took the occasion for another systematic campaign of noise measurements



uTCA crates cabling to 10 Gbit data network and white rabbit timing network

Systematic campaign of noise measurements 18-20/10

(for a detailed description see E-log entry 48 http://lbnodemo.ethz.ch:2500/3x1x1/48)

→ Identified some main noise sources **Camera boxes and LED/Heathers power cable**
→ When these two are disconnected the noise is at the **1.2 mV RMS** level

→ Systematic disconnections of all Slow control and HV cables from the cryostat reaches a noise around **0.7 mV RMS** close to nominal noise

→ Noise sources and residual impact of ground loops of slow-control cabling well understood

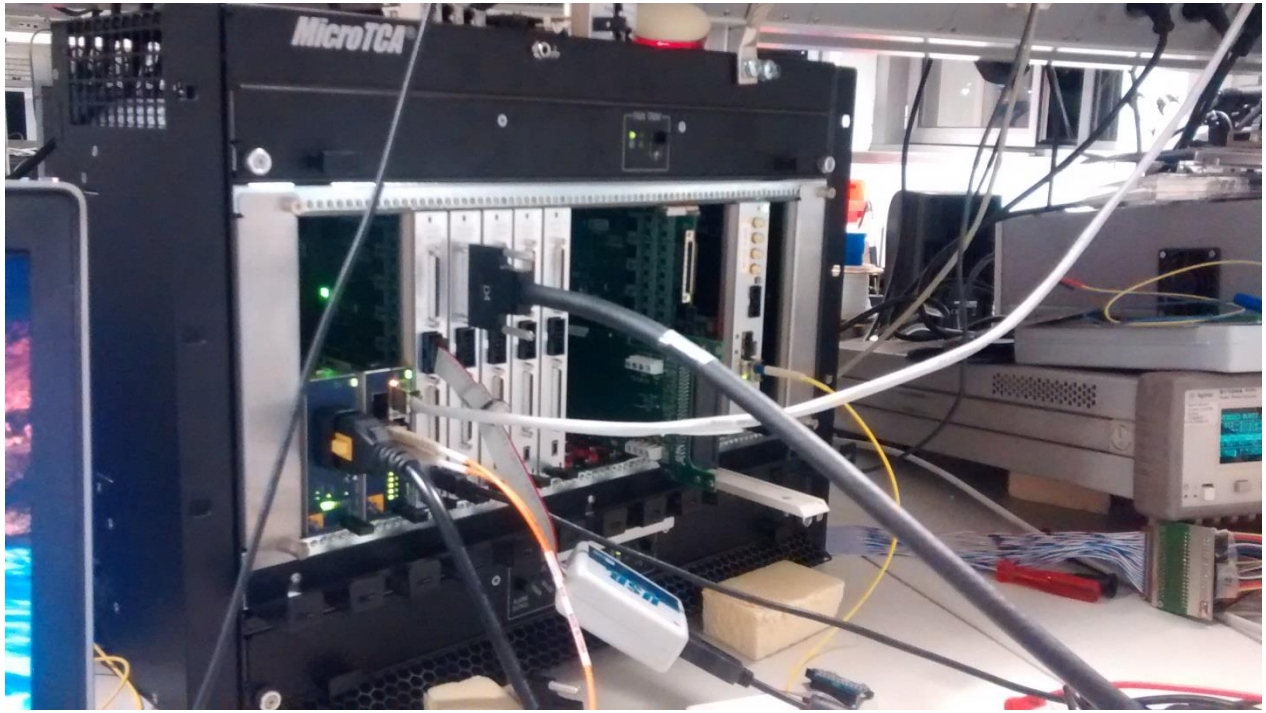
→ Checked that there is no additional noise from uTCA crates

Pulse at the scope of a m.i.p signal from charge injection in the anode strips

DAQ system installation completion 30/11-2/12

→ after one month of extensive tests in Lyon in November profiting of some delay of CERN cryogenics:

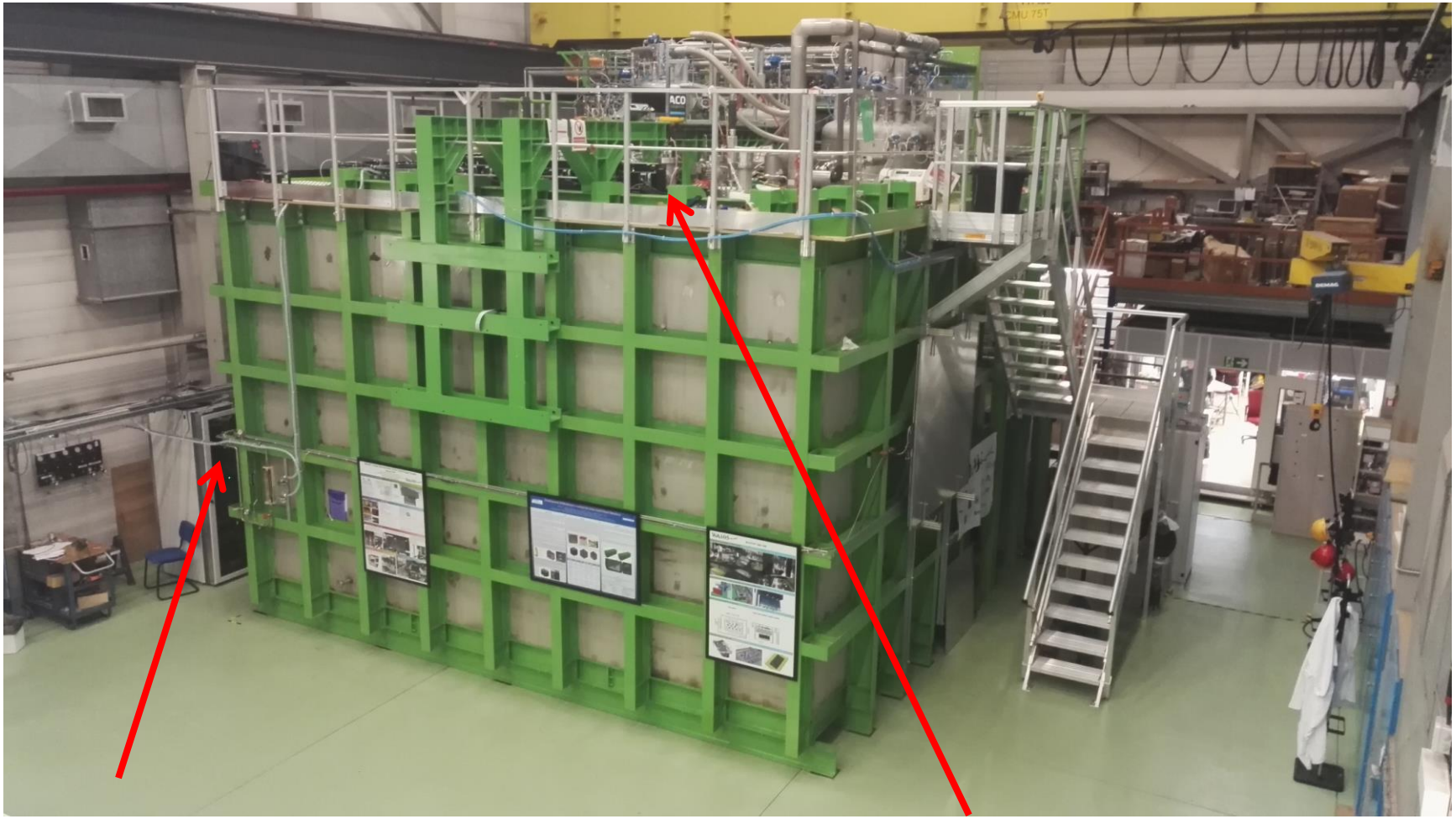
- Event builder software debugging (benefiting also of all previous experience with DAQ simulation system set up by Slavic and Bruno)
- Characterization and tests (no bad channels) of all the 20 AMC digitization cards



Test crate setup in Lyon

DAQ system installation completion 30/11-2/12
→ Complete system was fully commissioned on 2/12

uTCA cards, GPS and white rabbit system, event builder, run control, online data-storage and processing system, online event display

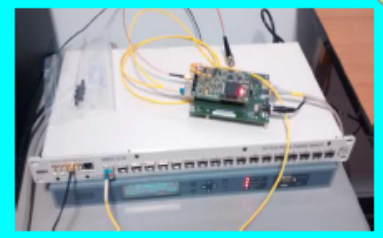


Event builder, network/GPS/White Rabbit GM
Trigger PC

Signal Chimneys and uTCA crates

White Rabbit scheme

- WR is an evolution of the synchronization scheme based on **synchronous Ethernet + PTP** which was previously developed at IPNL in 2008: http://arxiv.org/abs/0906.2325
- WR is accurate at sub-ns level, enough to align the 400ns samples
- At the level of the charge readout DAQ is distributed the beam trigger timestamp.
- Trigger time info starts and closes the acquisition of the samples belonging to the drift window of an event in each AMC (important when operating without ZS).
- The beam trigger can be time-stamped on the PC trigger board and be broadcasted to the microTCA crates via the WR time distribution network



Meinberg MASTER + WR switch + slave node

FMC Fine Delay 1 ns 4 channels

SPEC FMC PCIe carrier V4

White Rabbit uTCA slave node developed and produced for entire 6x6x6

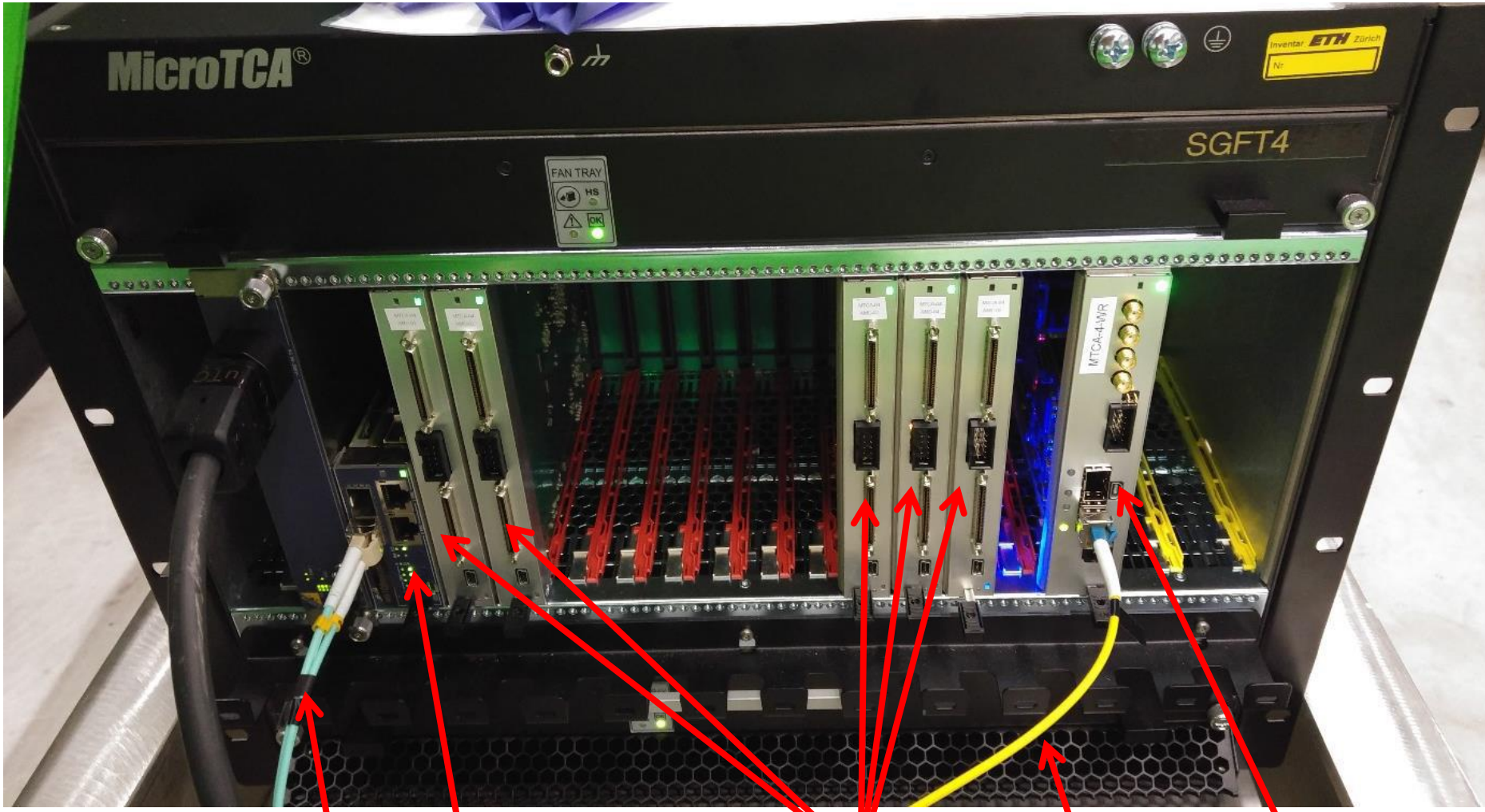
Other components of the chain (GPS receiver, WR grandmaster, trigger time tagging card and PC) purchased

White Rabbit trigger time-stamping PC

White Rabbit Grand-Master GPS unit

Event builder machine

How a crates was looking like before VHDCI signals cabling to the warm flange



MCH

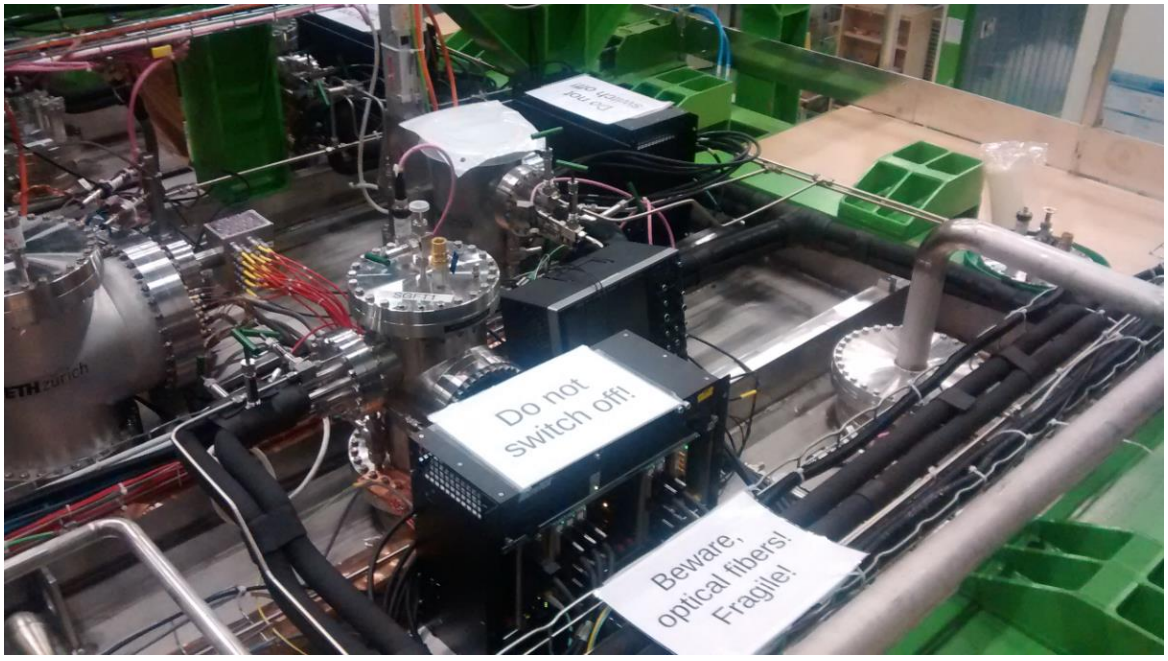
AMC 64 channels digitization cards

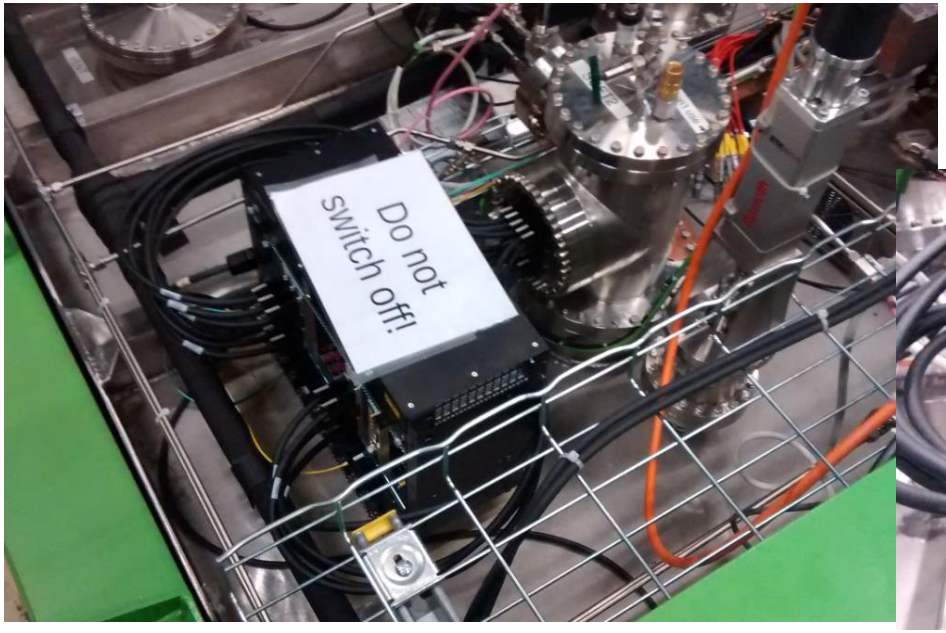
WR slave card node

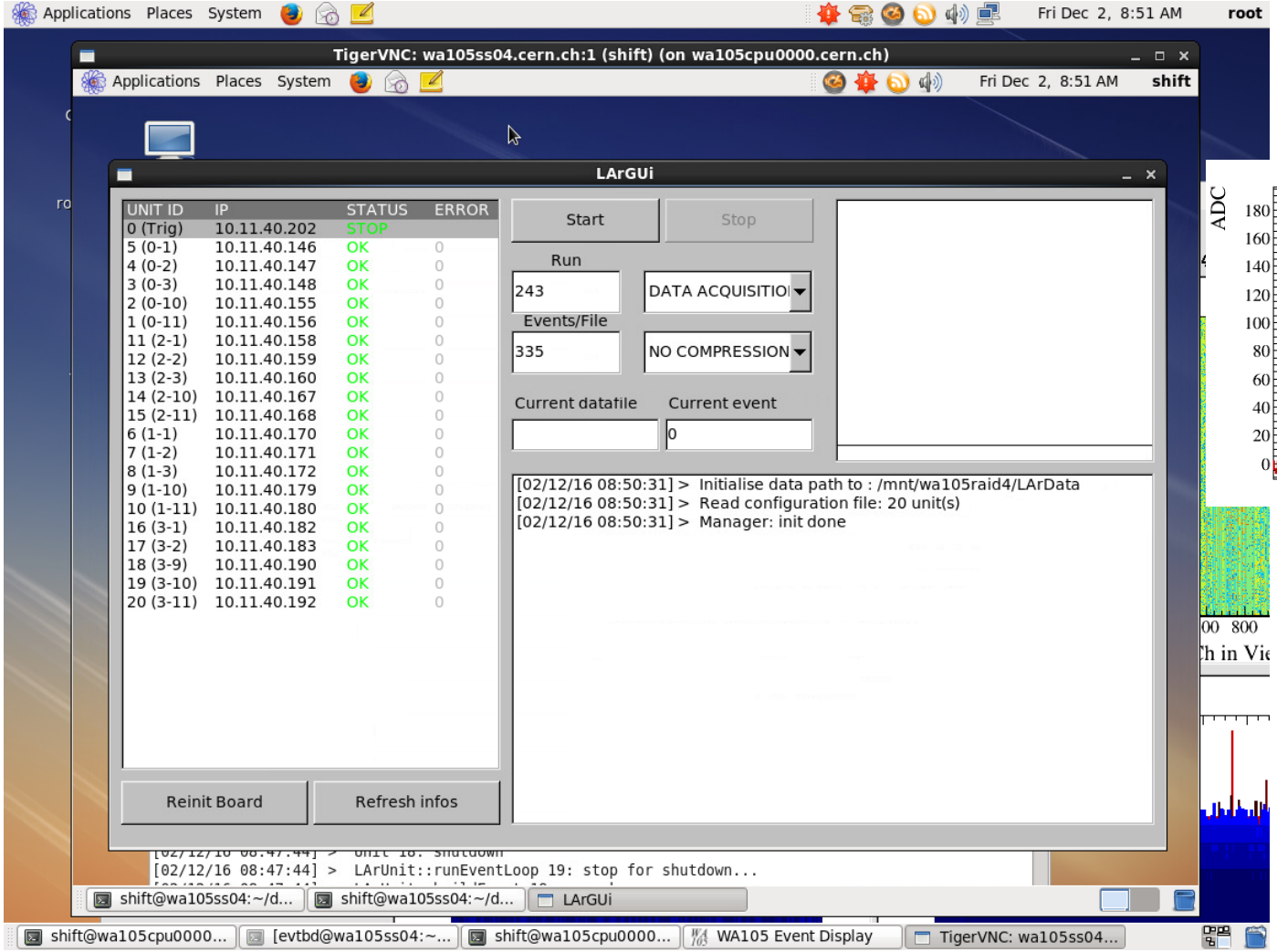
White Rabbit optical link

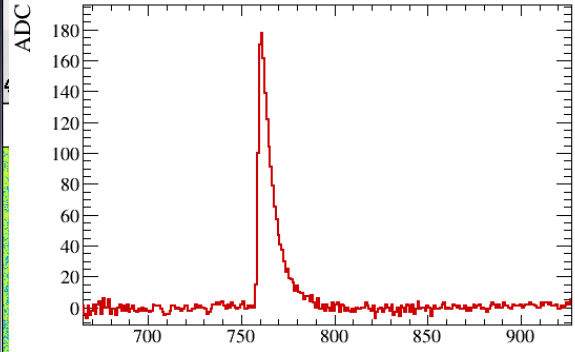
10 Gbit/s data link

Top cap views and details of uTCA crates completely cabled to the chimneys









Pulser mip signal from DAQ data

DAQ run control on Dec 2nd with the 4 uTCA crates (20 digitization boards)

- Simple interface, minimal work for shifters → just press start/stop
- System very stable also when left unattended taking data during night
- Confirmed previous noise measurements also with DAQ
- Automatic online processing of the files and transfer on EOS for access on lxplus

→ Instructions for shifters on how to run the DAQ

3x1x1 DAQ running from the shifter account

V1.0

7/12/1016

http://lbnodemo.ethz.ch:8080/Plone/wa105/daq/daq-shifters-instructions-for-3x1x1-running/view

▪Design of online storage/processing DAQ back-end farm completed in 2016 (1PB, 300 cores, 20Gb/s data flow),

DELL-based solution : configuration

storage servers :
* 15 R730XD (storage servers) including :
* 16 disks 6To
* 32Go RAM
* 2 disks system RAID 1, 300 Go 10k
* 1 network card Intel X540 double port 10 GB
* 4 years extended guarantee (D+1 intervention)
* 2 processors Intel Xeon E5-2609 v3
* raid H730P
* Rails with management arm
* double power supply

metadata servers (MDS) :
* 2 R630 (metadata servers), including :
* 2 disks 200 Go SSD SAS Mix Use MLC 12Gb/s
* 2 processors Intel Xeon E5-2630 v3
* 32Go DDR4
* RAID H730p
* network : Intel X540 2 ports 10 Gb
* 4 years extended guarantee (D+1 intervention)
* Rails with management arm
* double power supply

configuration server :
* 1 R430 (configuration server)
* 1 processor E5-2603 v3
* RAID H730
* 2 hard disks 500 Go Nearline SAS 6 Gbps 7,2k
* 16 Go DDR4
* Rails with management arm
* double power supply

Offline computing farm: 16*24 = 384 cores
* 1 blade center PowerEdge M1000e with 16 lames M630, each including :
* 128Go DDR4
* 2 processors Intel Xeon E5-2670 v3
* 4 years extended guarantee (D+1 intervention)
* 2 hard disks 500 Go SATA 7200 Tpm
* netwok Intel X540 10 Gb

Switch Force10, S4820T (see next slide) :
* 48 x 10GbaseT ports
* 4 x 40G QSFP+ ports
* 1 x AC PSU
* 2 fans

▪Prototype already installed and operative for 3x1x1
Tests to finalise the architecture of final farm
CERN/IT support for the procurement of the hardware

- 5 Storage servers 240 TB
- 3 QUAD CPU units → 300 cores

Online storage and data processing system also fully operative since the beginning of December

- EOS storage file system/metadata server
- Batch system: Torque
- Files transfer to EOS for users analysis access on lxplus
- Scripting and software developed for automatic files handling, storage, dispatching to batch workers and analysis
- Online analysis software for purity/gain determination, storing of results on EOS

Beyond use for 3x1x1 online monitoring (which has a rather modest data flow) this system is a prototype/test bench in order to study the design and perform the development of the final online data storage and processing system foreseen for the 6x6x6 via mock data challenges at high rate with both simulated and real data

Detailed presentation given by Elisabetta at the SB meeting on November 9th:

“Development and implementation of the WA105 6x6x6 online storage/processing on the 3x1x1 online storage and processing small scale test farm”

https://indico.fnal.gov/conferenceDisplay.py?confId=13286

Data flow

Binary files are written by the DAQ in the storage server of the proximity rack:
each file is composed by 335 events → 1GB/file (optimal file size for storage systems) not compressed

each run can be composed by several files (this number is not fixed):

run1-seq0.dat
run1-seq1.dat

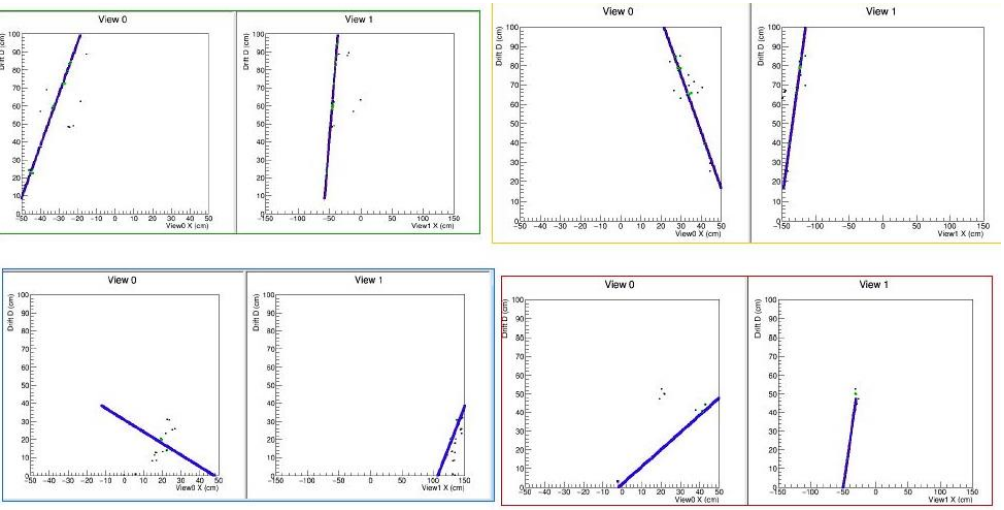
run2-seq0.dat
run2-seq1.dat
run2-seq2.dat
run2-seq3.dat
run2-seq4.dat

The automatic online data processing includes these 3 steps (not in strict time order):

1) As soon as a data file is produced, it is copied to the EOS storage area of the farm, a script to run reconstruction is automatically generated and submitted to the batch system
2) Results from reconstruction (root files) are also stored in the storage area and analyzed to evaluate purity and gain, to monitor the behavior of the detector in time (*online analysis*)
3) The binary data files are also copied to the central CERN EOS, where they are available to the users for offline analysis

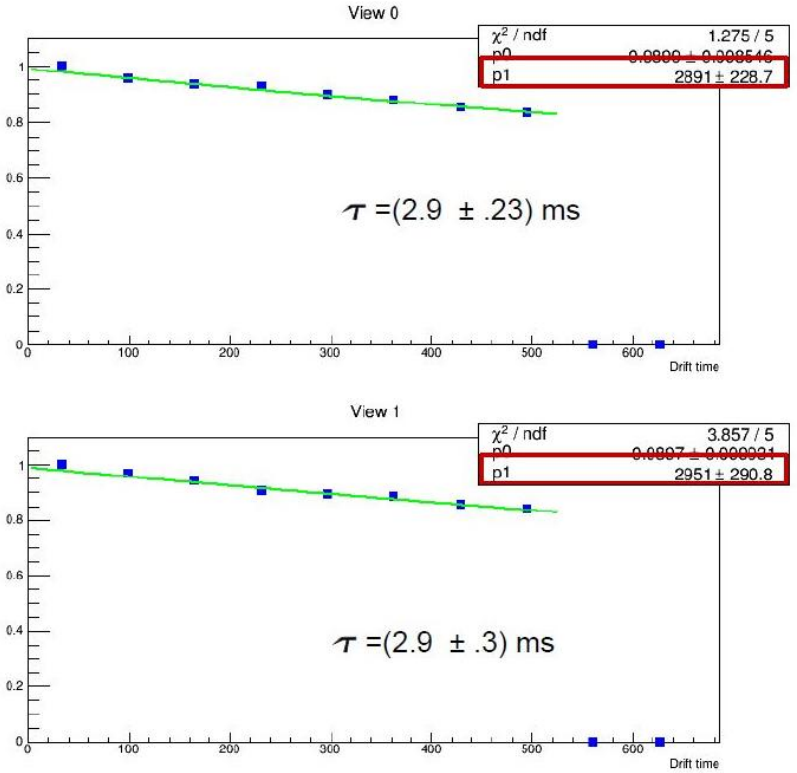
Note: Beyond the processing of the 3x1x1, which produces a very small data flow, the entire farm system is fundamental in "mock data challenges" and various tests in order to study and optimize the design of the final high rate system for the 6x6x6

Online liquid argon purity measurement and LEM gain measurement in 3x1x1



Examples from simulated data samples to set-up the online reconstruction system

results of purity measurement:



Campaign of 12-14/12:

- Last checks before closing man hole
- Correct some swaps in pulsing connection
- Repair warm flange PCB of SFT2 some connectors not properly welded by CERN workshop generating a large number of dead channels
- Check for additional sources of noise → pulser cables not shielded important source of noise
- Check on cryogenic system electronics (no effect) and on gas recirculation pump found some important effect → cryogenic people to improve pump grounding connection

Campaign of 11-13/1/2017:

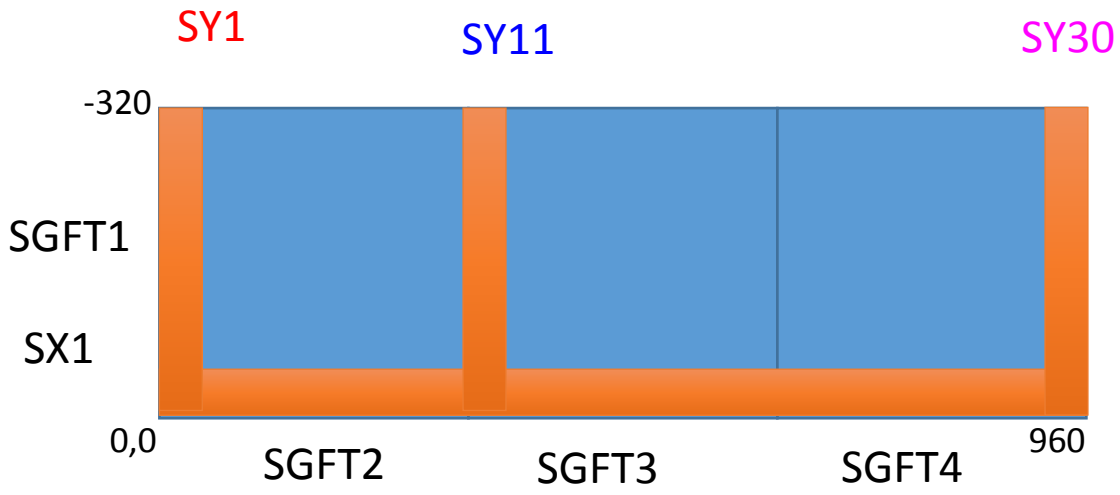
- Test noise from gas recirculation pump after ground improvements OK

Checks for additional noise sources:

- Test HV LEM on at 100 V OK
- Test HV cathode on at 1KV OK
- Test level meters on OK
- Systematic disconnections repeated of slow control cables (many configurations), confirmed what observed already in October

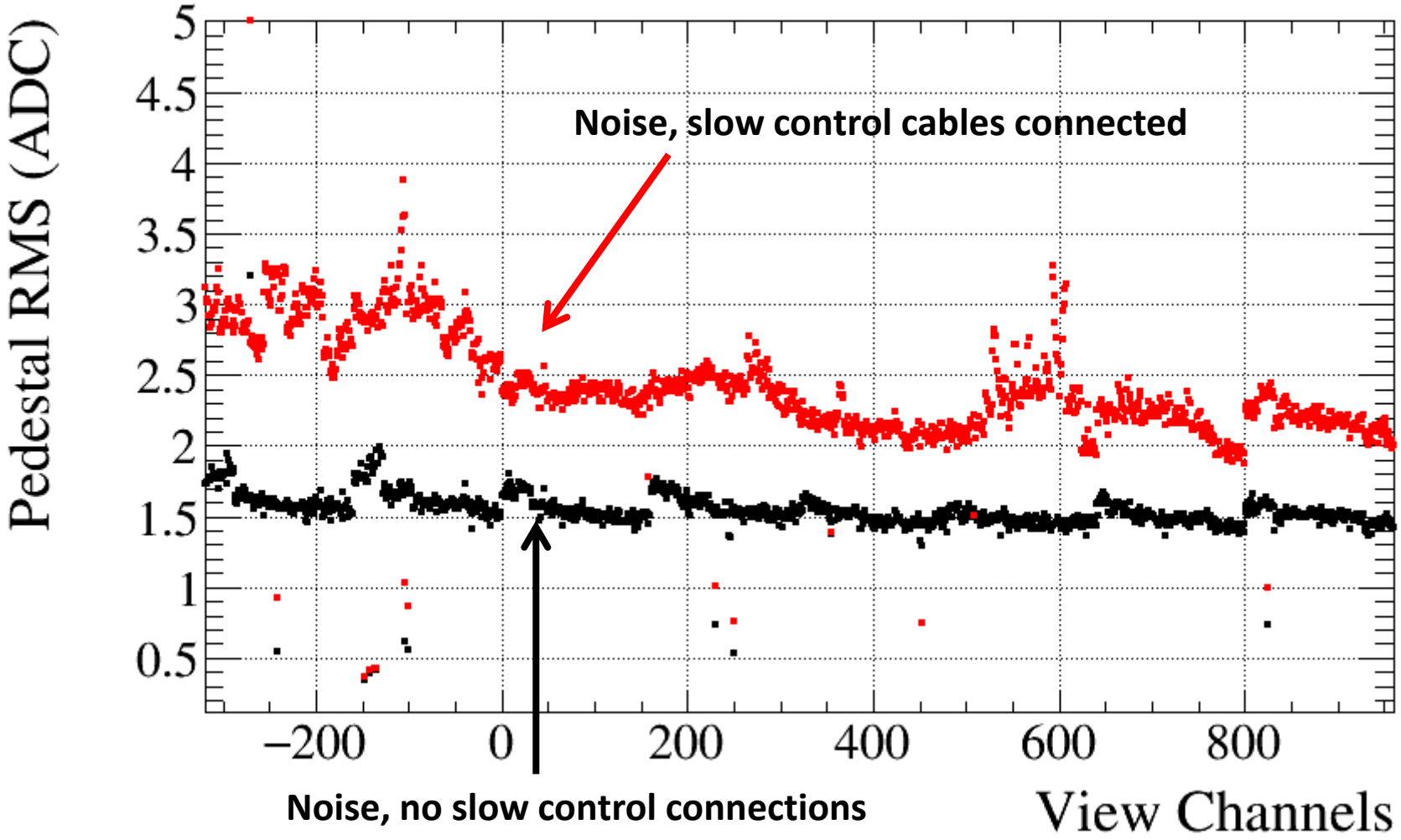
Channels numbering in the next slides:

All channels are mapped from DAQ numbering into continuous CRP coordinate



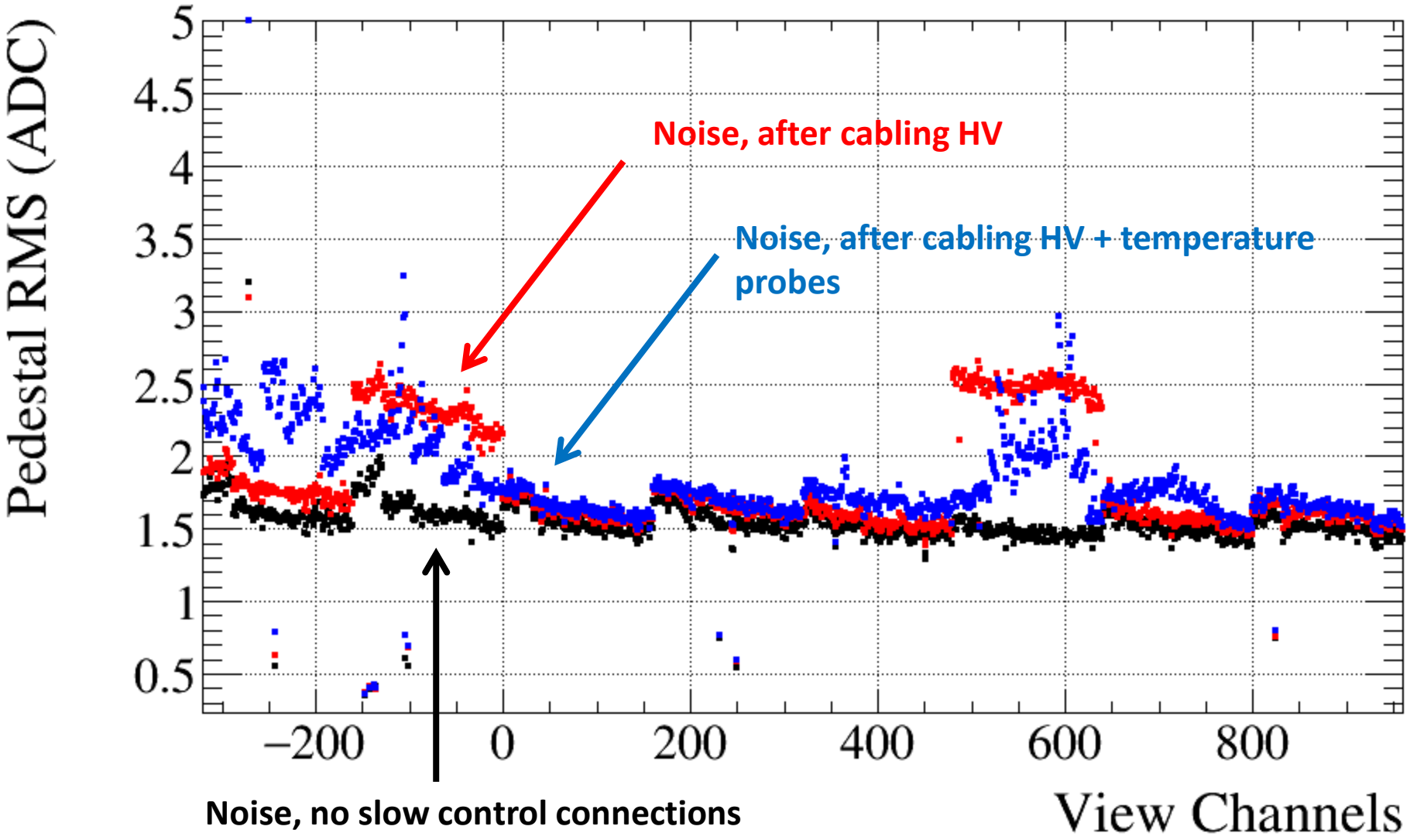
- Noise at warm **RMS~1.5 ADC channels (0.73 mV)** (all SC and HV disconnected apart cathode)

- Increases to **RMS~2.4 ADC channels (1.17 mV)** when the detector slow control cables are connected (slow control cabling and grounding not optimal in 3x1x1)



Discontinuities at the anode boundaries (0.5 m == 160 ch)

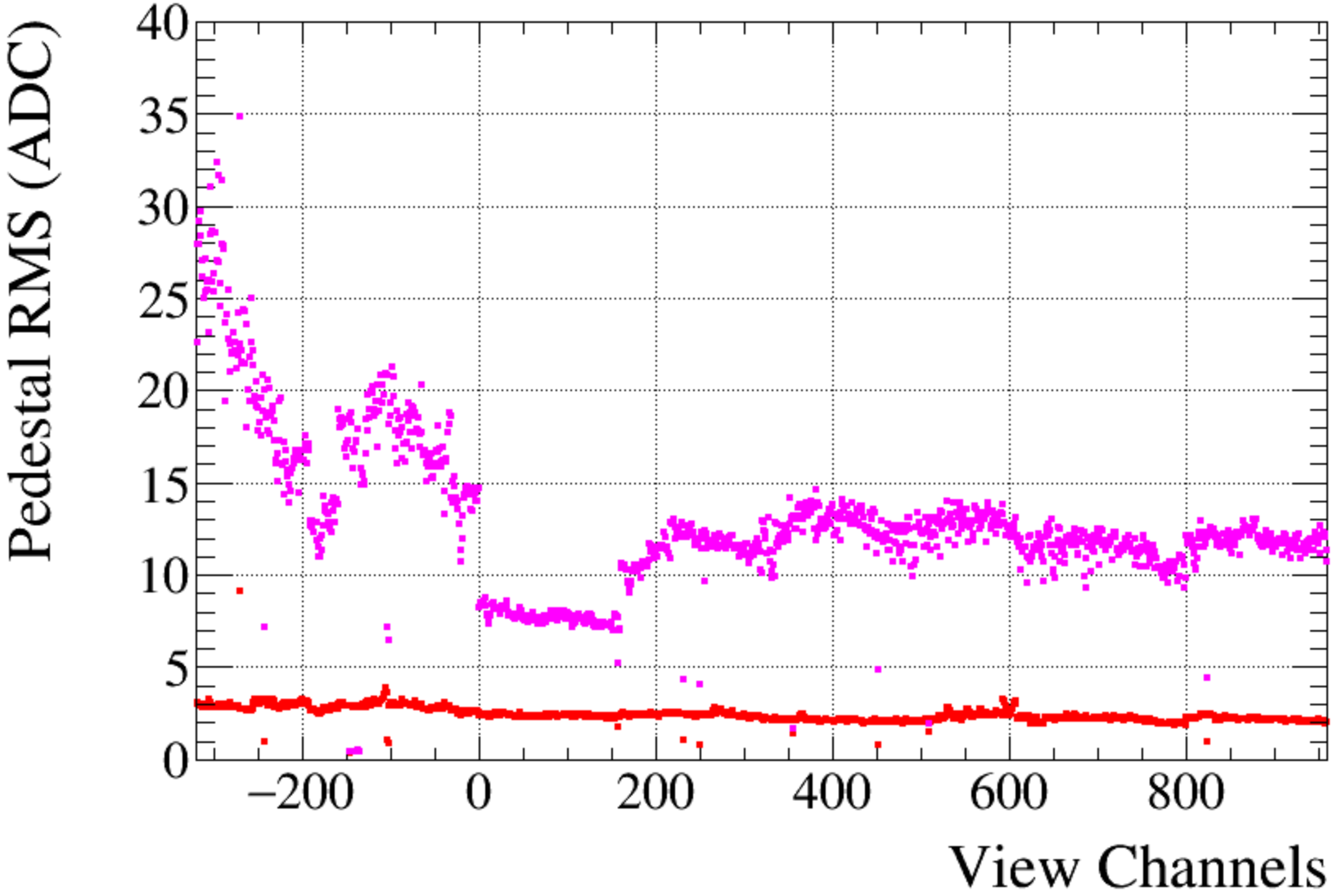
Complex pattern of interference in the slow control connections



Discontinuities at the anode boundaries (0.5 m == 160 ch)

LEM HV cables / T sensors / LVL meters / CAEN PSU is ON

Anode pulsing cable is connected to calibration flange



Connecting pulser cable to the calibration flange is a major source of noise

→ During data-taking it can (should) be left unplugged

Thanks to all the colleagues from Lyon for the very intensive work in the last months on the installation and commissioning of the FE and DAQ system